Developing preservice teachers' conceptualization of models and simulations through Group-based Cloud Computing

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Abstract

In this study, preservice elementary science teachers use Group-based Cloud Computing (GbCC) to engage in simulations about the reintroduction of wolves to Yellowstone. Participants developed concept maps and defined models and simulations before and after using GbCC. Findings include that through the intervention, participants moved from linear representations of concept maps towards more complex system-based representations. Although participants were able to articulate changes that they would like to make to the agent-based model, their limited programming knowledge was a barrier that prevented participants from implementing changes. In addition, misconceptions were uncovered regarding participants' definitions and uses for models and simulations. This research better informs how authorable agent-based models can help preservice teachers develop a deeper conceptual understanding of non-linear complex systems.

Research Goal

1. How do preservice teacher conceptions of ecosystem interactions in the complex scenario of Yellowstone shift after engaging with GbCC simulations?

2. How do preservice teachers engage with the authoring abilities of GbCC without explicit programming instruction?

3. Does engaging with GbCC simulations change preservice teacher conceptions about the nature of models, simulations, or their uses in the classroom?

Methods

This research reports on a single case study within a larger design-based research project (Creswell, 2014). Participants included 24 preservice teachers enrolled in an elementary science methods course (Table 1).

Table 1
Data collected throughout the GbCC modeling case study

Data Collected	Description
Lesson 1: Introduction to Models and Ecosystems (30 minutes)	
Pre-Modeling Questionnaire (RQ3)	Participants recorded their initial definitions of models and simulations, and described their uses in class.
Pre-Modeling Concept Maps (RQ1)	Participants constructed initial concept maps of species interactions in Yellowstone National Park
Lesson 2: Exploring Group-based Cloud Computing Simulations (1 hour 45 minutes)	
Classroom artifacts from modeling experience (RQ2)	Photographs of participant plans to evaluate and revise the GbCC models were captured.
Post-Modeling Concept Maps (RQ1)	Participants constructed final concept maps of species interactions in Yellowstone National Park
Post-Modeling Questionnaire (RQ3)	Participants recorded their final definitions of models and simulations, and described their uses in class.

Results and Discussion

Group-based Cloud Computing Models
Group-based Cloud Computing (GbCC) is an agent-based program, powered by *NetLogo Web* (Wilensky, 1999), that enables learners to work collaboratively to participate in, author, and share models (Petrosino & Stroup, 2017). This study uses modified GbCC versions of the NetLogo Wolf-Sheep Predation model (Wilensky, 1997) to explore the reintroduction of wolves to Yellowstone National Park (Figure 1). The model allows users to explore wolf and elk populations and draw conclusions about their impacts on the Aspen tree population. Participants can manipulate variables and share them to a group gallery space.

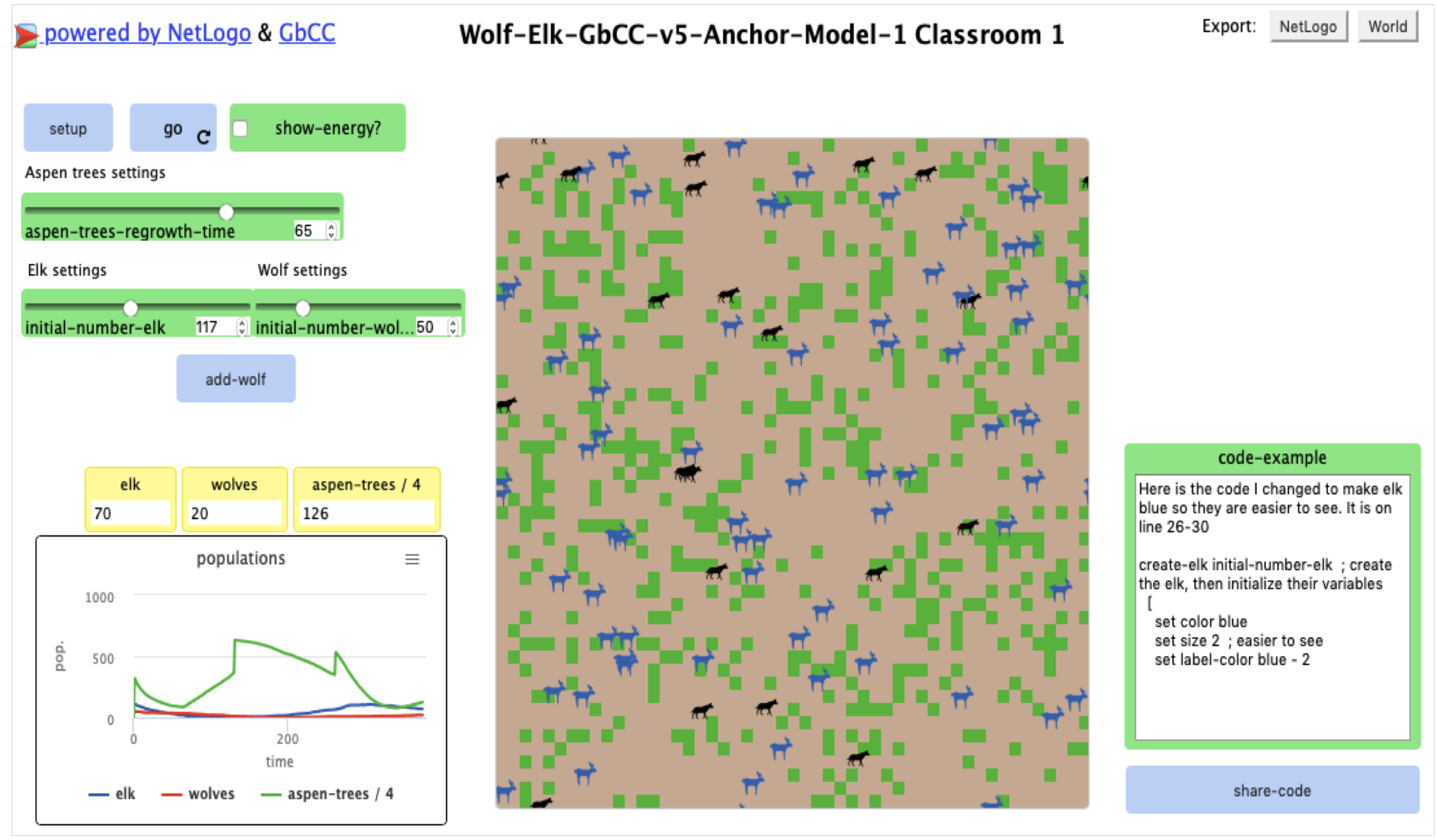

Figure 1
GbCC Wolf-Elk Model with sliders to control wolf and elk populations, elk regrowth time, graphs to plot populations, and a section to annotate and share your model to the gallery space.

RQ 1: Ecological Conceptual Change
Participants constructed concept maps to demonstrate their understanding before and after the modeling experience to determine if the modeling experience supported thinking about complex systems (Danish & Thompson, 2017). Individuals with a greater understanding of a system will typically represent concept maps with more connections, as in the *network* classification of concept maps (Yin, Valindes, Ruiz-Primo, Ayala, & Shavelson, 2005). We found that after engaging with GbCC simulations fewer participants opted for linear structures and instead used tree (Figure 2) and network structured concepts map (Figure 3).

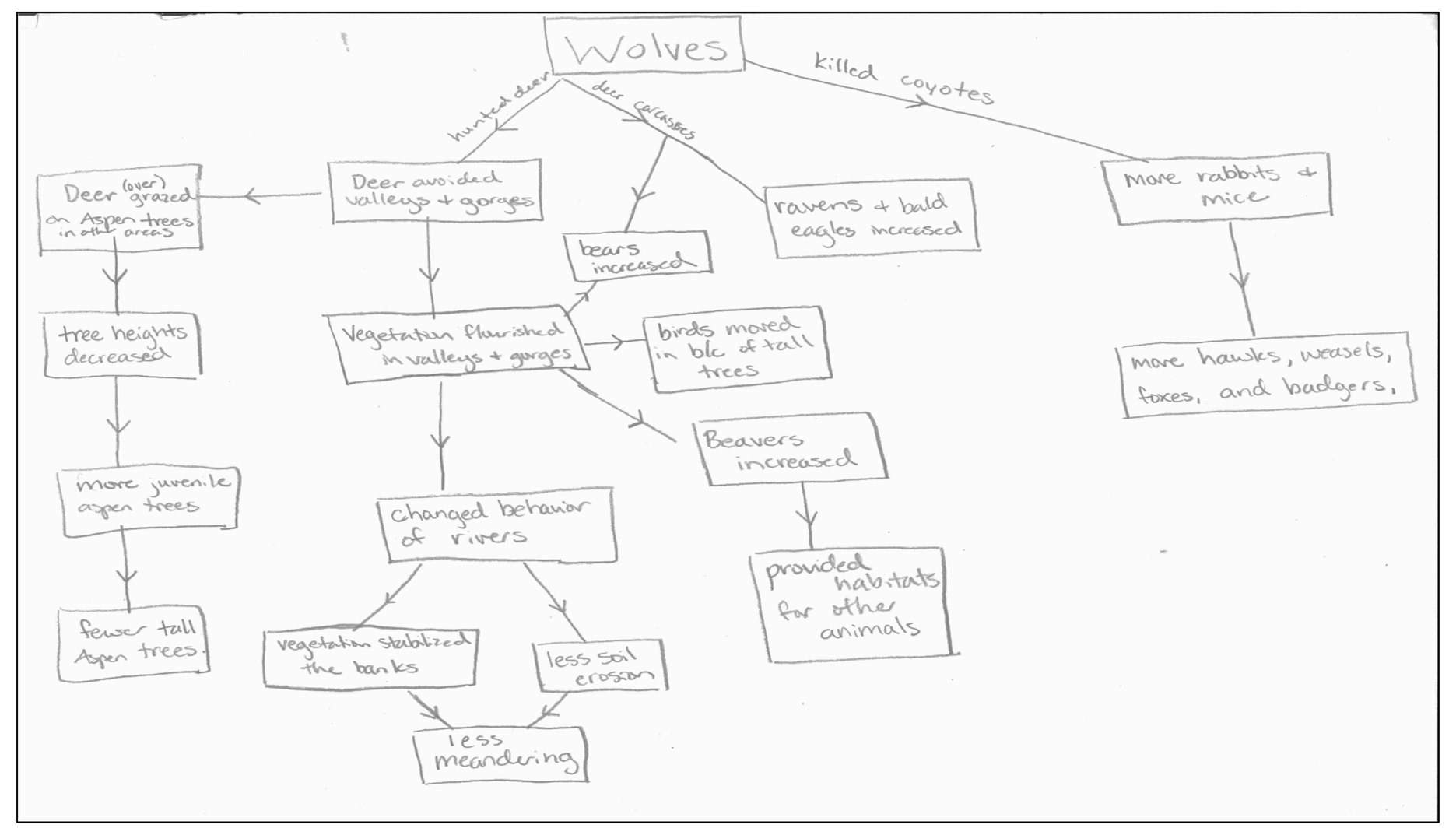

Figure 2
Example of a students' post-modeling experience tree-concept map

Figure 3
Example of a students' post-modeling experience network-concept map

RQ 2: Modifying the Model
Evaluating the affordances and limitations of models and making revisions is an important modeling practice for learners to engage in. Participants were asked to evaluate the initial models, read more about the growth habit of Aspen trees, and propose modifications to the model. Analyzing classroom artifacts related to the proposed modifications showed that participants fell within one of three categories: (a) visual planning (Figure 4); (b) pseudo-coding (Figure 5); and (c) actual-coding (Figure 6).

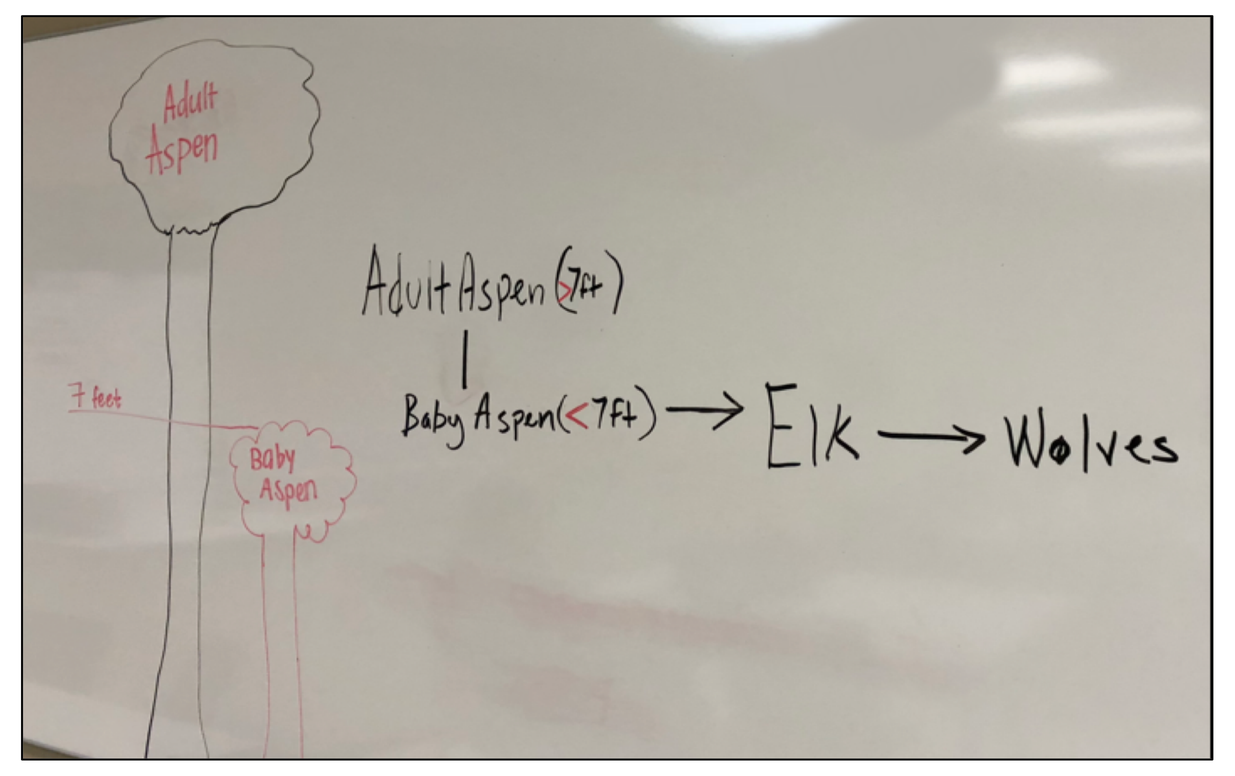

Figure 4
Most participants engaged in visual planning changes, focusing on rules for how elk would graze on aspen depending on the height.

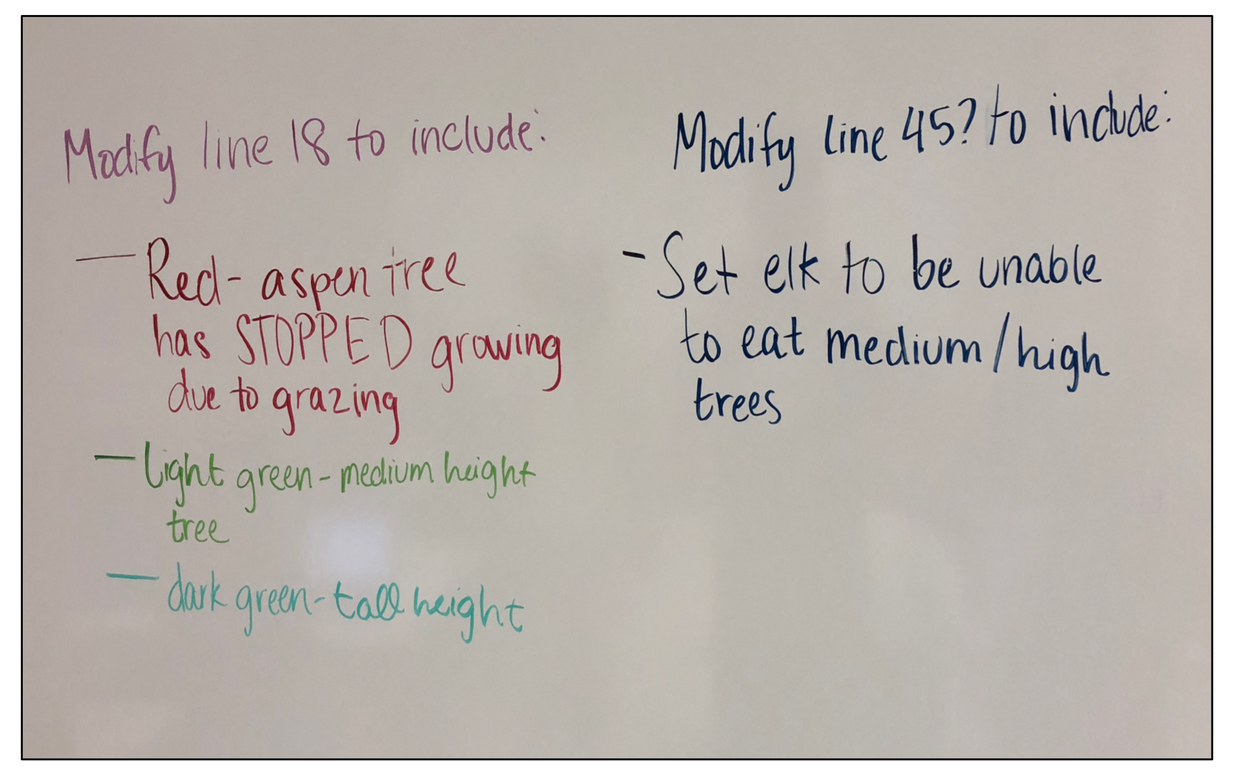

Figure 5
Some students engaged in pseudo-coding, or planning algorithmic rules for how to modify the functioning of the models.

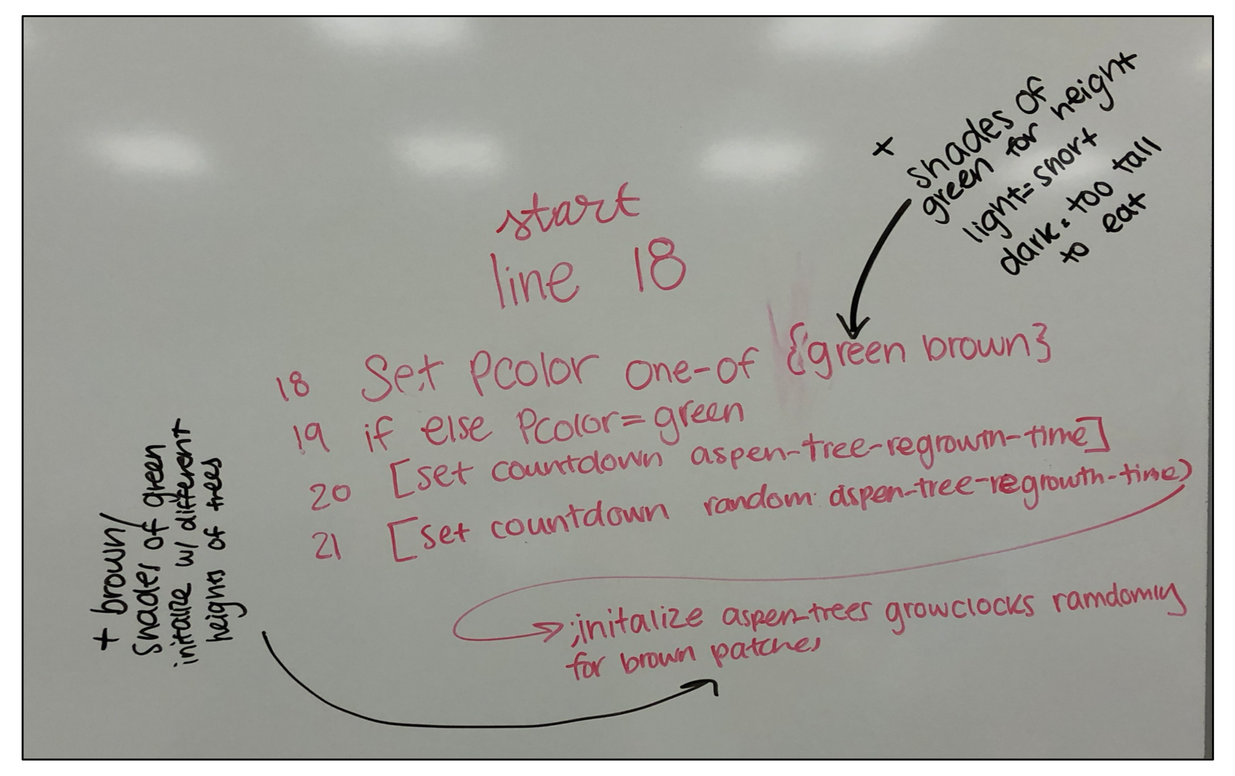

Figure 6
Two student groups attempted to engage in actual modification of the NetLogo programming language to produce modifications.

Results and Discussion

RQ 3: Conceptions of Models and Simulations
Conversations throughout the Yellowstone experience demonstrated that preservice teachers have conceptual misunderstandings about the definitions of models and simulations. Furthermore, preservice teachers often described the two as separate; rather than considering simulations to be a type of model.

When asked to describe what models and simulations are used for the in the classroom, participants clung tightly to notions of both models and simulations as representations (Table 2). Despite engaging in models to simulate various scenarios and generate conclusions, participants still viewed them as tools for representing a phenomenon for teaching. Participants did not mention other uses of models such as tools for: (a) generation of new knowledge; (b) evaluation of prior knowledge; or (c) predicting new phenomena.

Table 2
Frequency of key words used to describe the use of models and simulations

Models				**Simulations**			
Code	Pre	Post	Change	Code	Pre	Post	Change
Demonstration	0	0	0	Demonstration	2	0	-2
Replication	0	0	0	Replication	4	0	-4
Representation	15	15	0	Representation	4	6	2
Summary	0	1	1	Summary	0	0	0
Tool	1	0	-1	Tool	1	0	-1

Conclusion

This exploratory study emphasizes the possibility of using GbCC simulations to access higher forms of model practice and metamodeling knowledge. Additional research needs to include metamodeling knowledge conversations in order to yield more accurate and aligned conceptions of the terms models and simulations. This research will serve future studies that allow for more time and instructional supports that allow preservice teachers to fully explore the possibilities of authoring changes to models or simulations.

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